Salmon Program

State Recovery Projects
Application Project Summary

TITLE: Lower Big Beef Creek Design - 134	**NUMBER:** 09-1642N (Non-Capital)
	STATUS: Preapplication

APPLICANT: Hood Canal SEG	**CONTACT:** Neil Werner
	(360) 275-0373

COSTS:

RCO	$54,000	100 %
Local	$0	0 %
Total	$54,000	100 %

SPONSOR MATCH:

DESCRIPTION:

Big Beef Creek is one of three watersheds which had subpopulations of summer chum salmon extirpated but recently reintroduced as a cornerstone strategy to recovering this federally-listed ESA species in Hood Canal and the Eastern Strait of Juan de Fuca. Habitat capacity in lower Big Beef Creek where summer chum salmon spawn, incubate, and rear is relatively poor given the stream straightening and simplification that occurred in 1969 and the removal of persistent woody debris. In addition, an access road on a raised foundation to a series of wells providing water for the University of Washington's Fish Research Facility has not allowed the stream to passively recover from channel simplification, except when extreme flood events allow overtopping into a significant floodplain complex and 10+ acre wetland.

This proposed design project will seek to actively restore properly functioning floodplain and channel conditions within the lower 1 mile of Big Beef Creek. Within the constraints provided by the need to maintain the waterline and the UW capital facilities, we will design a large scale restoration project to minimize the road prism, reconnect several side channels and wetlands, and install as many as 30 log jam structures. A revegetation plan will be developed to be included in the future construction proposal, if needed.

Additionally, this project implements a corrective action in a treatment watershed of the Hood Canal IMW program, partnering with WA Ecology and Fish & Wildlife to implement validation monitoring.

LOCATION INFORMATION:

LEAD ENTITY ORG: Hood Canal Coor Council LE

COUNTY:

GOAL & OBJECTIVE:

The goal of the project is to increase/improve information to help select projects that have a high certainty and benefit.
The objective of the project is to determine project siting, feasibility, design, or implementation.

PERMITS ANTICIPATED:

None - No permits Required

SALMON INFORMATION: (* indicates primary)

Species Targeted

Chinook	Cutthroat
Chum*	Searun Cutthroat
Coho	Steelhead

Habitat Factors Addressed

Biological Processes	Floodplain Conditions*
Channel Conditions	Streambed Sediment Conditions

LAST UPDATED: June 19, 2009	**DATE PRINTED:** June 25, 2009

Non Capital Cost Estimate Summary

Hood Canal SEG

Lower Big Beef Creek Design - 134

Element/Item	Unit	Quantity	Unit Cost	Total Cost	Description Needed	Description
Worksite #1, Lower Big Beef Creek						
Communications						
Printing, binding, copying	Lump sum	1.00	$1,000.00	$1,000.00	Optional	Telephone, final report printing, etc
Permits						
Permits	Lump sum	1.00	$3,000.00	$3,000.00	Optional	permit applications
Professional Services						
Surveying	Lump sum	1.00	$7,500.00	$7,500.00	Optional	topo of dike and wetland; update
Professional services - other	Lump sum	1.00	$2,500.00	$2,500.00	Optional	soil pits to verify waterline location/depth
Consultant(s)	Lump sum	1.00	$5,000.00	$5,000.00	Optional	revisit hydrology with new flood data
Consultant(s)	Lump sum	1.00	$20,000.00	$20,000.00	Optional	plans and specifications
Salaries & Benefits						
Salaries & Benefits - other	# of FTE's	.20	$50,000.00	$10,000.00	Title	Project Manager
Salaries & Benefits - other	# of FTE's	.10	$50,000.00	$5,000.00	Title	Admin/Billing

Project Tax Amount $0.00

Project A&E Amount $0.00

Project Total Costs   **$54,000.00**
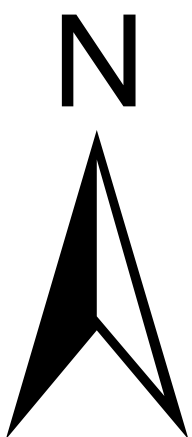
Big Beef Field Station

N

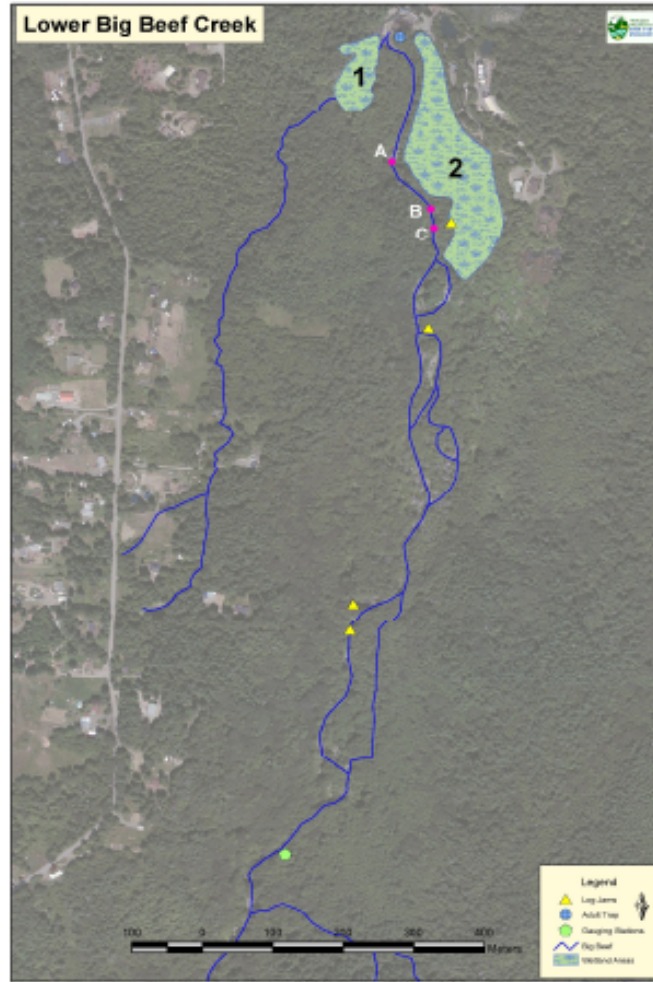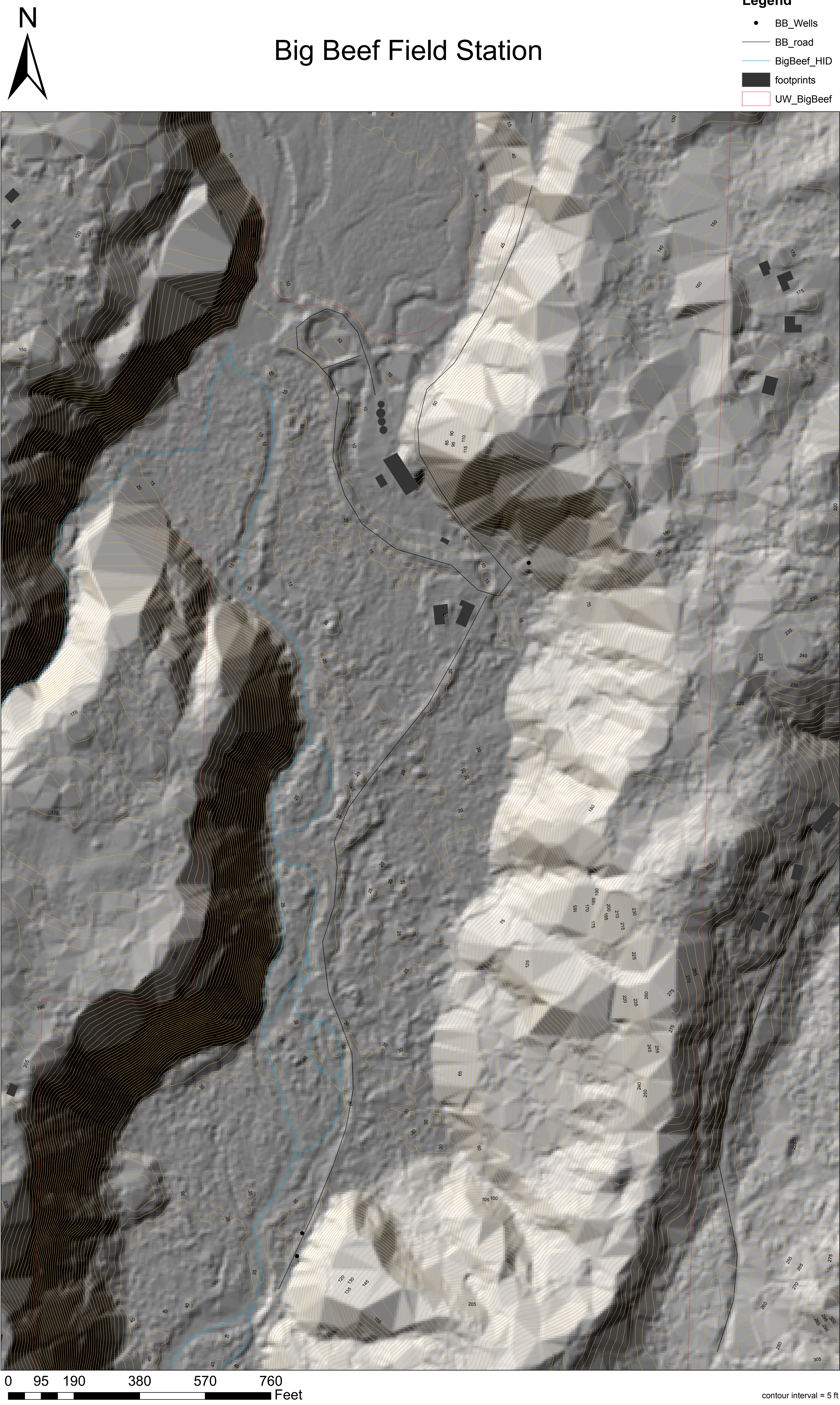0   95   190   380   570   760
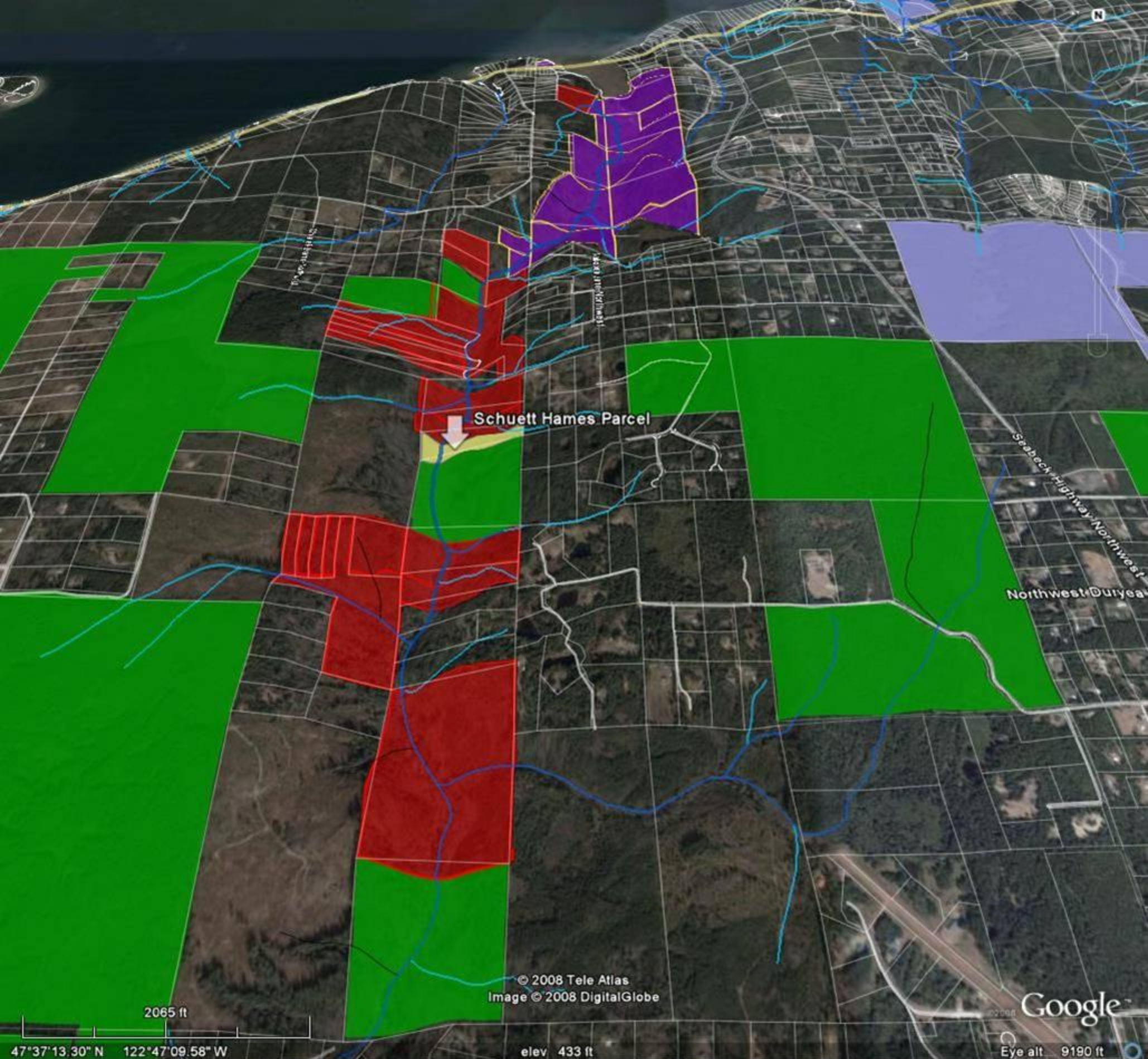Feet

contour interval = 5 ft

Figure 1. Lower 2.2 km of Big Beef Cr. showing wetland connectivity locations (A-C), existing LWD jams, and monitoring station near the confluence with Hood Canal

Big Beef Field Station

N

| 0 | 95 | 190 | 380 | 570 | 760 |

Feet

contour interval = 5 ft

Schuett Hames Parcel

47°37'13.30" N   122°47'09.58" W   elev 433 ft   Eye alt   9190 ft

© 2008 Tele Atlas
Image © 2008 DigitalGlobe

Google

Hood Canal SEG; Lower Big Beef Creek Design - 134 (#09-1642)
Attachment #2, Property Ownership Map

Salmon Recovery Funding Board's
Intensively Monitored Watersheds

Little Anderson

Seabeck

Stavis
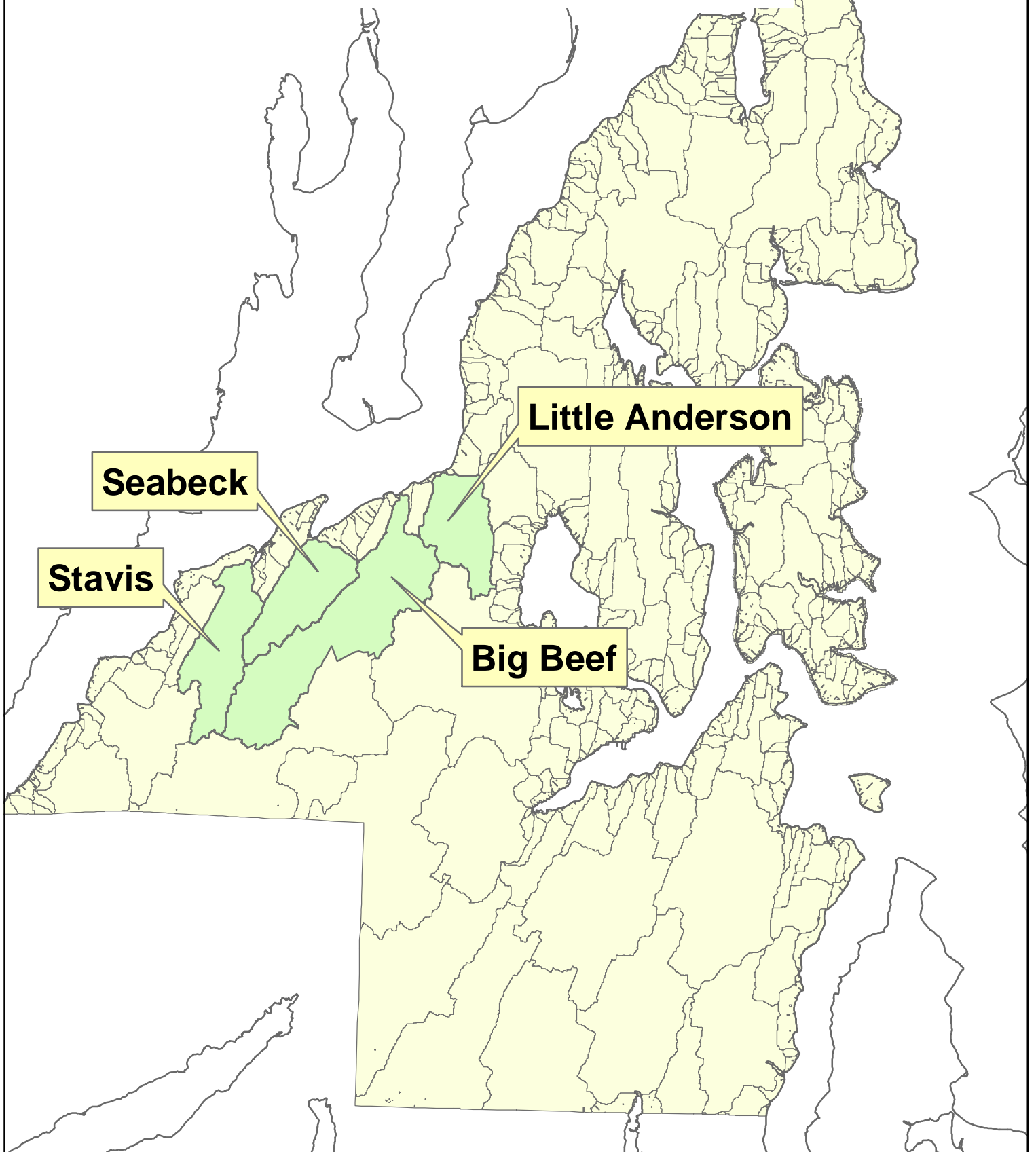
Big Beef

Flood Hazard Assessment of Lower Big Beef Creek
Seabeck, Washington

For
Pat McCullough
ESA Engineering

December 31, 2001

By
Douglas L. Johnson, P.E.
Consulting Engineer

# Flood Hazard Assessment of Lower Big Beef Creek
Seabeck, Washington

This report summarizes engineering analyses performed to assess flooding on lower Big Beef Creek at the University of Washington Big Beef Creek (BBC) Field Station. The work was done under agreement with Pat McCullough of ESA Engineering. The scope of work under this agreement included:

1. Determining the vulnerability of existing structures and spawning channel at the BBC Field Station to flooding.
2. Minimum modifications needed to protect same structures from flooding at 100, 200 and 500-year events.
3. Effects on Field Station if upstream access road dike is breached, allowing floods to enter wetland area.
4. Modifications that would be needed to accomplish No. 3, without jeopardizing structures at Field Station.

Introduction

Big Beef Creek is located on the west side of the Kitsap Peninsula in Kitsap County, Washington. The stream flows northward for a total of 11 miles until it enters Hood Canal approximately 5 miles northeast of the community of Seabeck. The Big Beef Creek drainage basin has a total area of 13.8 square miles at the USGS Gauging Station, about 3500 feet upstream from the field station.

Figure 1: Lower Big Beef Creek
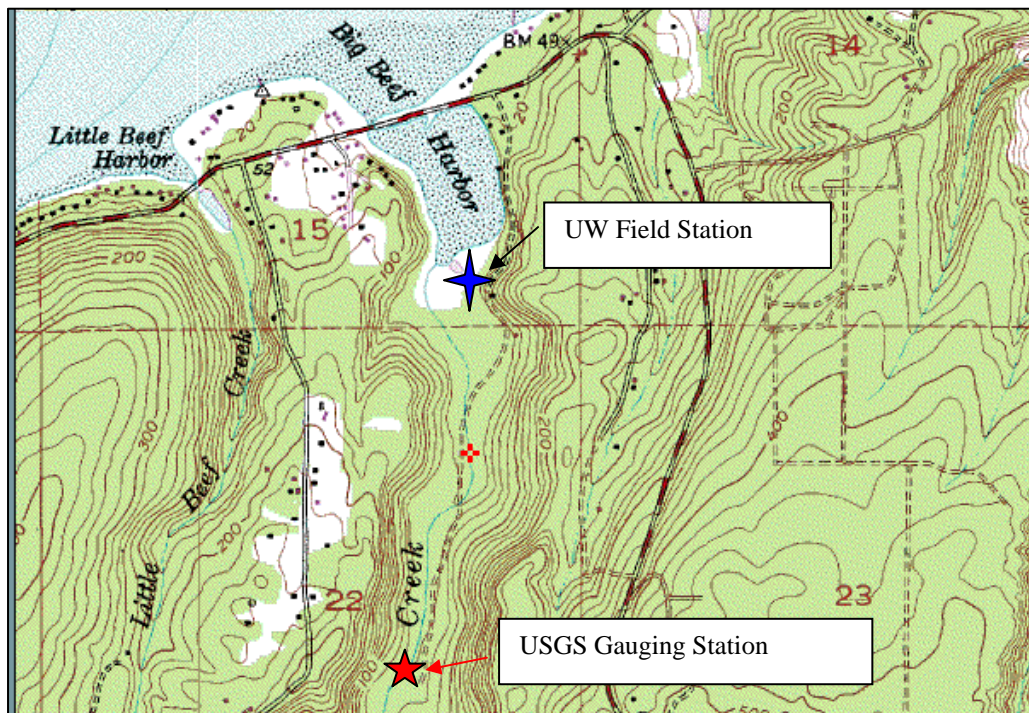
In recent years, the Field Station and adjacent area have been hit with major floods that have resulted in damages to structures and other facilities. The flood of Jan 1, 1997 nearly breached a road dike upstream from the field station, which could have sent floodwaters into a wetland area on the east side of the valley, and subsequently into the spawning channel and surrounding structures. This flood had a peak discharge of 1840 cubic feet per second (cfs), which approximates the 100-year flood for this location. Another major flood occurred on February 24, 1999 that had a discharge of over 1200 cfs. These floods and the potential for them to breach the road dike and cause flooding at the field station prompted this analysis.

Flood Frequency Estimates

The first step in the assessment was to perform a flood frequency analysis for Big Beef Creek at the site. The gage data from USGS Station 12069550, Big Beef Creek near Seabeck, Wash was used[1]. This data was used directly in the analysis, although the gage is actually located some 3500 feet upstream from the field station. This data was deemed adequate for the purposes of this study, however, as the additional drainage area below the gage is negligible in relation to the overall size of the basin. The USGS gage has 19 years of peak flow data for this location: Water years 1970-81, and 1994-2000. The peak streamflow data is shown in Table 1.

Table 1: Peak Streamflow Data for Big Beef Creek Near Seabeck (USGS 12069550)

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)	Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1970	Dec. 22, 1969	3.88	384	1979	Feb. 25, 1979	4.92	459
1971	Dec. 7, 1970	4.92	757	1980	Dec. 18, 1979	5.66	617
1972	Jan. 20, 1972	4.39	572	1981	Dec. 27, 1980	4.59	392
1973	Dec. 26, 1972	4.69	712	1994	Dec. 10, 1993	5.31	561
1974	Jan. 16, 1974	5.74		1995	Oct. 31, 1994	2.53	

|						
			742			49.0
	1975				1996	
Feb. 12, 1975				Dec. 11, 1995		
			4.92			5.57
			368			640
	1976				1997	
Oct. 29, 1975				Jan. 1, 1997		
			5.52			6.97
			688			1,840
	1977				1998	
Mar. 8, 1977				Jan. 23, 1998		
			5.28			5.03
			592			680
	1978				1999	
Dec. 11, 1977				Feb. 24, 1999		
			5.05			
			500			1,200[1,6]
					2000	
				Nov. 11, 1999		
						4.59
						535[6]

This data was then input into the USGS computer program PEAKFQ[2], which performs a flood frequency analysis using Bulletin 17B guidelines. A total of 19 flood peaks were entered into the program. The 1999 and 2000 peak flows were used, even though they were flagged by the USGS to indicate the effects of regulation or diversion. However, I elected to include them because the 1999 peak was significant (2nd largest on record) and any recent changes in upstream regulation/urbanization are minor.

The results of this analysis are shown in Table 2. The results include both the Bulletin 17B Estimate and the upper bound for 80% confidence limits. Figure 2 shows a plot of the data on log-probability paper.

Table 2: Annual Peak Flow Frequency Results

Annual Exceedance Probability	Recurrence Interval	Bulletin 17B Estimate (cfs)	80% Confidence Upper Limit (cfs)
.02	50-year	1530	1810
.01	100-year	1770	2150
.005	200-year	2040	2520
.002	500-year	2430	3090

Figure 2: Plot of Annual Peak Flow Frequency
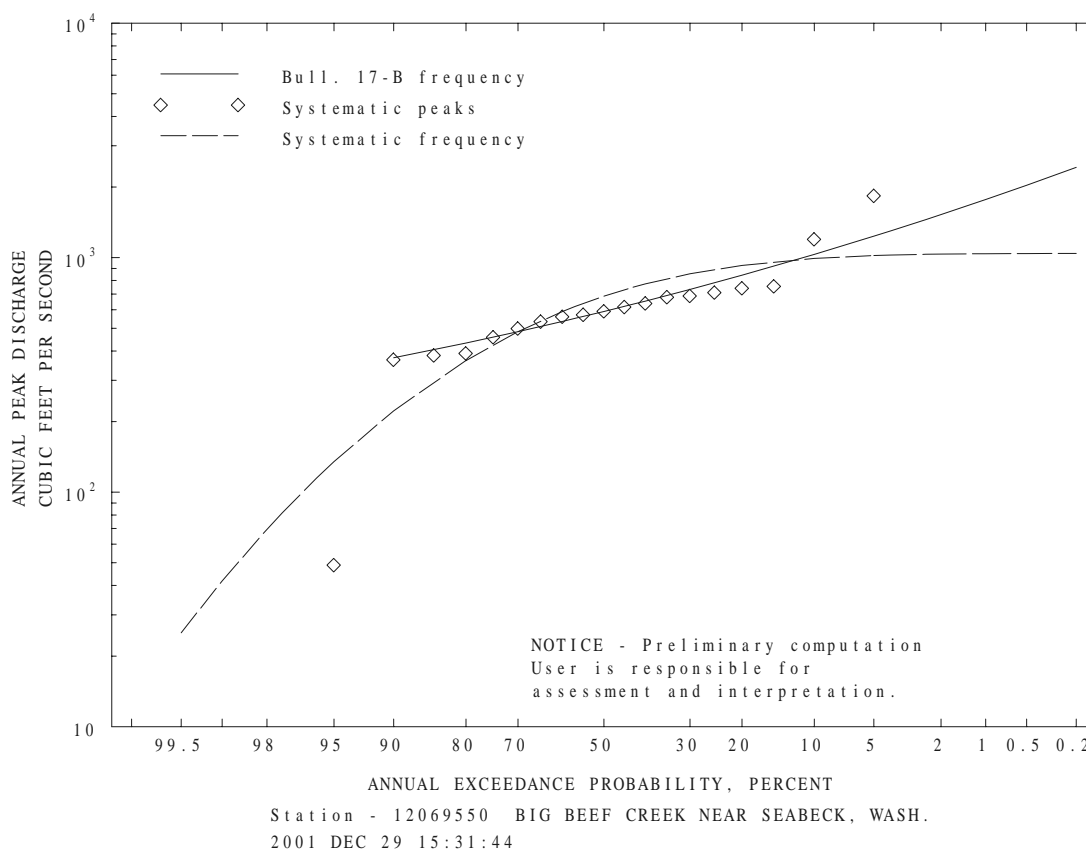
HEC-RAS Computer Model

The next step in the analysis was to set up the US Army Corps of Engineers computer model HEC-RAS[3] River Analysis System Version 3.0 to determine the extent of flooding for the different discharges listed in Table 2. HEC-RAS is software designed to perform one-dimensional steady and unsteady flow river hydraulics calculations. The steady-flow option of the model was used in this analysis. Input data to the model included:

1. Cross sections across the valley floor, starting at the fish screen weir at the mouth of Big Beef Creek and extending upstream about 2800 feet. Cross section information was supplied by Pat McCullough of ESA Engineering, who computed the sections based on LIDAR survey data provided by Kitsap County. A few additional cross sections were also surveyed on the ground by ESA. A total of 20 cross sections were input into the HEC-RAS model, which are shown in Appendix A of the report. The base map showing the valley and cross section locations is shown in Figure 3.

Figure 3 – Map of Big Beef Creek showing Cross Section Locations

2. Manning's roughness coefficients for each reach between cross sections. Roughness coefficients at critical locations were calibrated based on estimated flood levels during the 1997 flood of 1840 cfs. Otherwise, nominal values of .05 for the main channel and .07 for the overbank were used.

3. Ineffective flow areas, blocked obstructions, and natural levees, which were used to simulate the conditions present in the natural valley cross-sections.

Once the base model was set up in HEC-RAS, different geometries and flow conditions were applied to meet the scope of work.

Case 1: Vulnerability of Facilities to Flooding Under Existing Conditions

The first case studied in the model was the existing stream and man-made geometry at the site. According to Pat McCullough, there is an old road grade that parallels Big Beef Creek to the east, which acts as a dike or levee under high flow conditions. In the area from cross section 4 to 5, the creek overtopped the road dike in the 1997 flood, and required sandbagging and emergency repairs to keep it from failing. As shown in Figure 4, the Big Beef Creek channel is actually sitting a few feet higher than the wetland area to the east. Should the creek breach the road dike in this area during a flood, it could change course and run into the wetland area, which subsequently discharges into the UW Spawning channel and adjacent roads and buildings. Thus, as it currently exists the road dike is critical to keeping Big Beef Creek within its existing channel.

Figure 4: Cross Sections 4 and 5
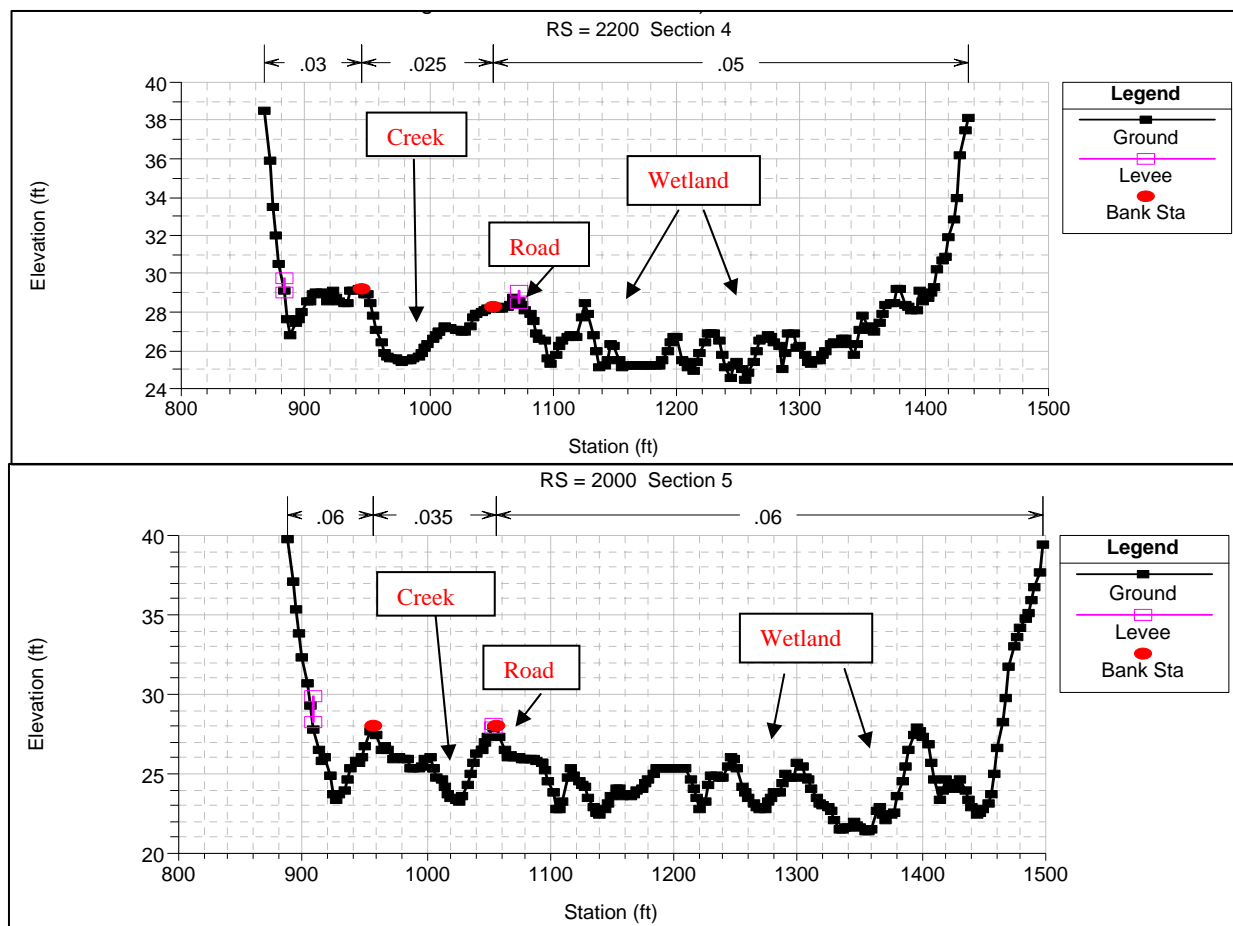
The HEC-RAS Model runs indicated that the existing channel has less than 100-year flood capacity. In fact, the analysis shows that the channel could not handle the 1997 flood of 1840 cfs without significantly overtopping the road dike. This may be due to sediment deposition over the past few years, which has reduced the channel capacity. At Cross Section 4, the channel appears to have about a 50-year flood capacity before the road overtops.

The next step in this analysis was to determine what happens in the likely event of the road dike failing during large floods (100, 200 and 500-year events). In modeling this case, it was conservatively assumed that the road dike would breach and the entire flow of Big Beef Creek would enter the wetland area. This is not an unreasonable assumption, as the wetland area is lower than the creek, and the stream would likely downcut during a flood event, diverting most of the flow to the wetland. Under this scenario, the creek would flow through the wetland, overtop the Field Station entry road near Section 10, and flow into the spawning channel. As shown in Figure 5, flooding would inundate the channel and would likely damage the adjacent buildings at the Field Station.

Figure 5: Flooding at Field Station and Spawning Channel
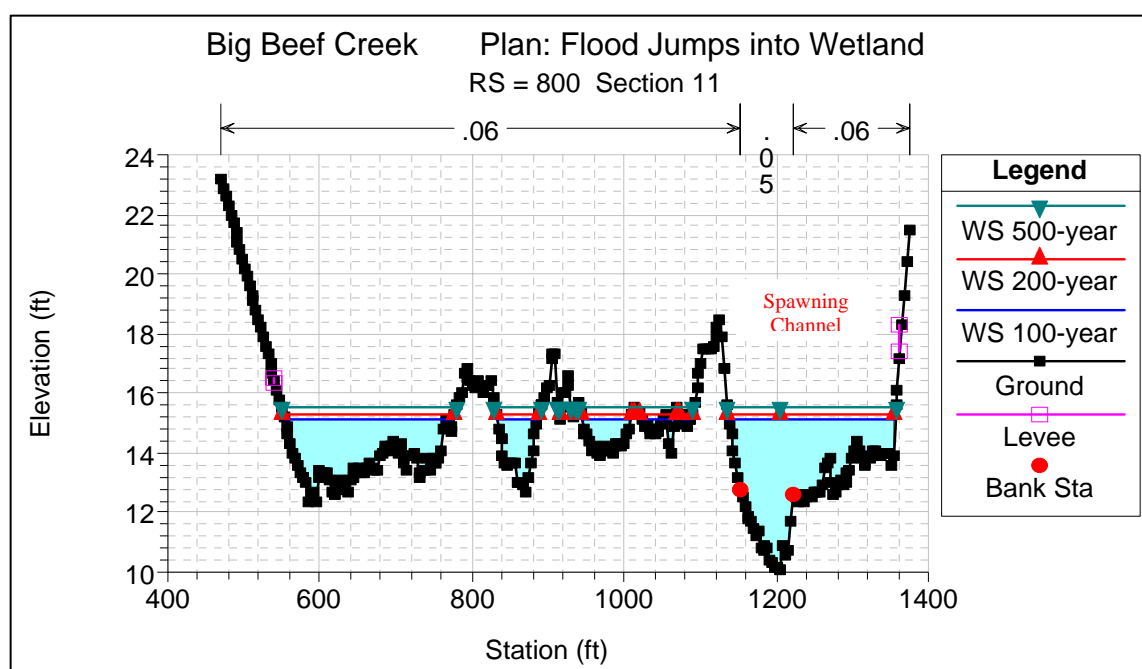
Thus, given the likelihood of the road dike near Sections 4 and 5 failing, and given that most of the flood flow would pass through the wetland, overtop the entry road and flood the spawning channel, it is clear that facilities at the UW Field Station are currently vulnerable to damage during large flood events.

Case 2: Minimum Modifications to Protect Facilities from Large Floods

Case 2 looks at making some modifications along the access road to the field station to protect the spawning channel and adjacent structures from flooding. This approach is probably more cost-effective than attempting to fortify over 200 feet of the road dike near Section 4 to prevent overtopping and failure during a major flood event. The modifications would involve adding fill to the Field Station entry road where it crosses the wetland, and along the road that parallels

the west side of the spawning channel (See Figure 6). The elevation of the raised road depends on the level of protection desired. Table 4 lists the road elevations plus freeboard needed for the 100, 200 and 500 year floods. It also lists the elevations required for the 80% confidence values.

Table 4: Road Elevations Required to Protect Against Major Floods (Case 2)

Flood Event	Computed Flood Elevation	Road Elevation (w/ 0.5 foot Freeboard)	80% Confidence Flood Elevation	80% Confidence Road Elevation
100-year	17.9 ft.	18.4 ft.	18.1 ft.	18.6 ft.
200-year	18.0 ft.	18.5 ft.	18.5 ft.	19.0 ft.
500-year	18.4 ft.	18.9 ft.	18.7 ft.	19.2 ft.

Figure 6: Plan View of Area of Road Raise
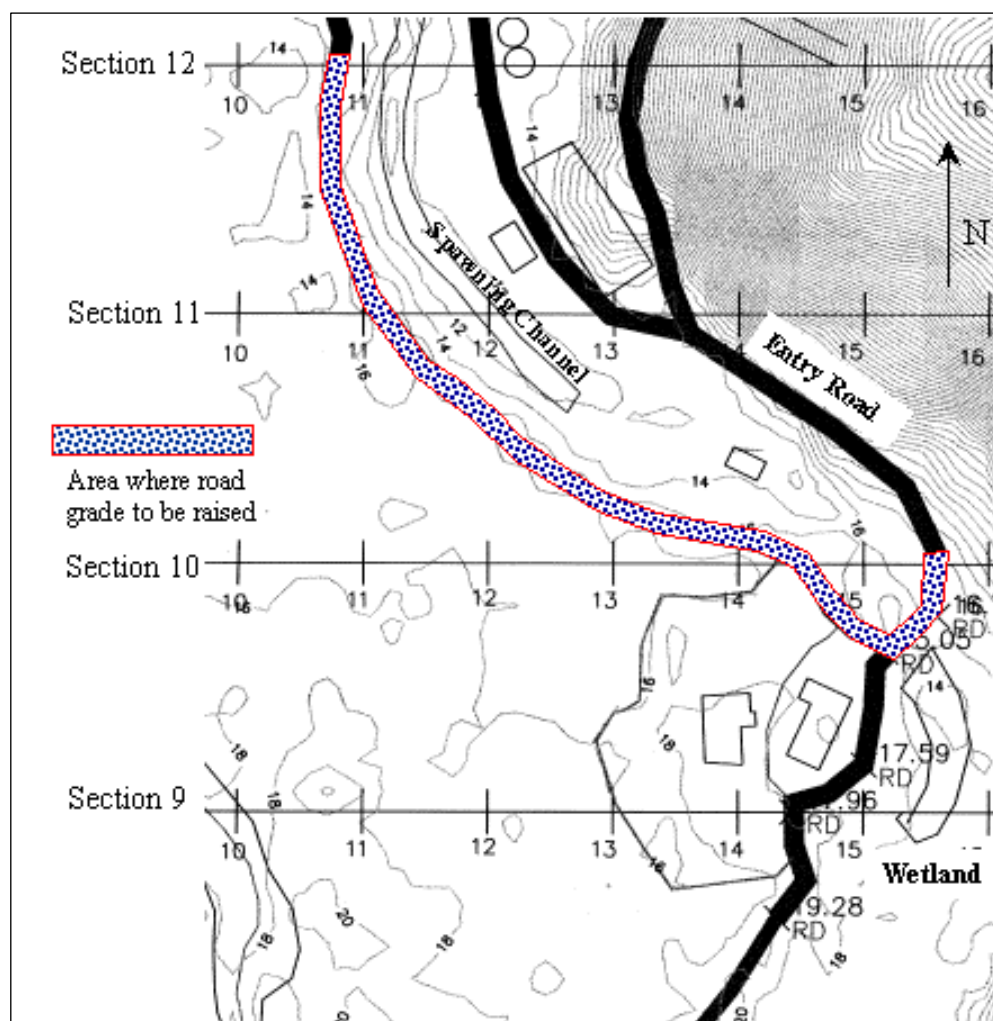
It should be noted that this modification scheme is intended only to prevent flood flows from overtopping the entry or west perimeter road and flooding the spawning channel. Under this scheme, floodwaters would flow uncontrolled across the parking lot and storage buildings between sections 9 and 10. There could be erosion and scour in this area. Also, this option

would not prevent Big Beef Creek from forming a new channel through the wetland area, and dewatering portions of the current channel.

Case 3: Breach Road Dike, Allow Flooding in Wetland, No Mods. at Field Station

The next case was to look at the effects if the wetland was opened up to flooding by removing portions of the road dike between section 4 and 5. According to Mr. McCullough, the UW is interested in restoring the wetland area, which has been cut off from flood overflows for many years by the access road dike. They are interested in removing the dike in the vicinity of Sections 4 and 5, because this is the area where overtopping occurred in the past. This scenario looks only at removing the upstream dike and does not include any means to return flows from the wetland to the main stream channel. Nor does it include the road modifications discussed in Case 2. The purpose here is to look at the effects of intentionally removing a portion of the road dike to let floodwaters enter the wetland.

The first step was to determine an elevation for the base of the removed section of the dike. It was assumed that it was not desirable to allow annual flood events into the wetland; thus, a 5-year flood elevation of 28.0 feet was selected at Section 4 for the base elevation of the breach (Figure 7). Extensive erosion protection would be required at the floor of the breach, to prevent headward erosion and downcutting. Even with this protection, it would still be possible for the creek to cut a new channel into the wetland.

Figure 7: Potential Breach Elevations at Section 4
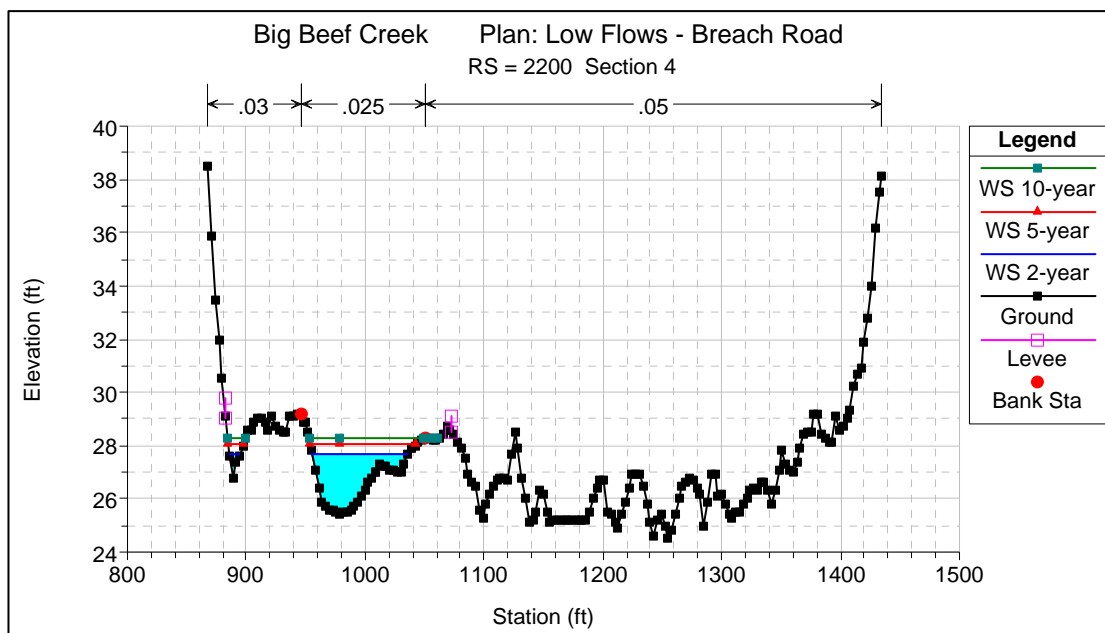
The results of this analysis were nearly identical to Case 1. Even if erosion protection was provided at the breach section, it is still possible that most of the flood flow would enter the wetland channel. Since there is no means of returning flow to the main creek from the wetland, the floodwaters would overtop the Field Station entry road, as well as the adjacent parking lot and buildings. Flood damage would be expected in the spawning channel and adjacent buildings. Clearly, the upstream road could not be breached without making provisions for retuning flow to the main creek channel, and making modifications to protect the hatchery channel.

Case 4: Breach Road, Add Return Flow Channel, Protect Spawning Channel

The final case examined is the one recommended if the UW decides to reopen the wetland area to flood flows. This would involve breaching the road dike as in Case 2, but providing a return-flow channel near Section 8 to discharge flows from the wetland back to the main stream channel. Figure 8 shows a plan view of the proposed return flow channel section. The return flow channel was modeled as being 100 feet wide between Sections 8 and 9, with a floor varying from elevation 16 to elevation 17 feet. The length of the channel would vary from 100 to 130 feet, and would involve excavation of up to a 4-foot depth. The upstream road dike was assumed to have been breached for a width of 100 feet as in Case 3. This would again require some sort of erosion cutoff to prevent the creek from eroding a new channel into the wetland. However, since the road breach section would be located along an outside bend, and since the existing channel is perched above the surrounding valley floor, there is still the possibility of the creek eroding through any erosion protection and cutting a new channel. Thus, it may be desirable to locate the breach of the road dike away from the main Big Beef Creek channel. As shown in Figure 9, a breach near Cross Section 3 would be safer, provided that the topography could carry the overflow to the wetland. Additional detailed surveying of this area is recommended if this location is chosen.

It should also be noted that under this scenario, the entry road would still have to be raised to protect the spawning channel and structures. However, the addition of the return flow channel would make the required road elevations slightly lower, as shown in Table 5.

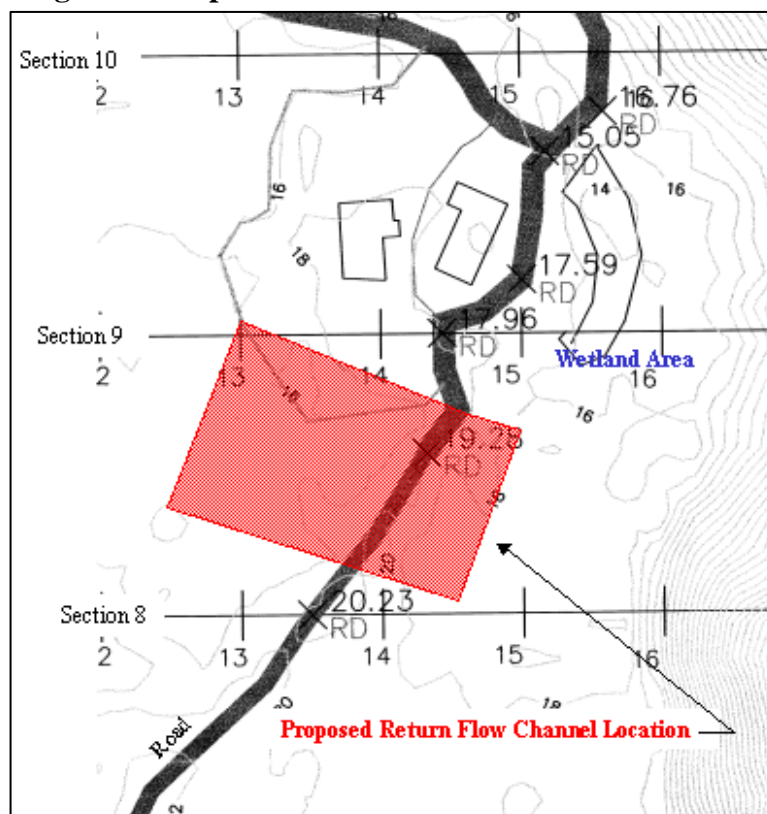## Figure 8: Proposed Return Flow Channel Location

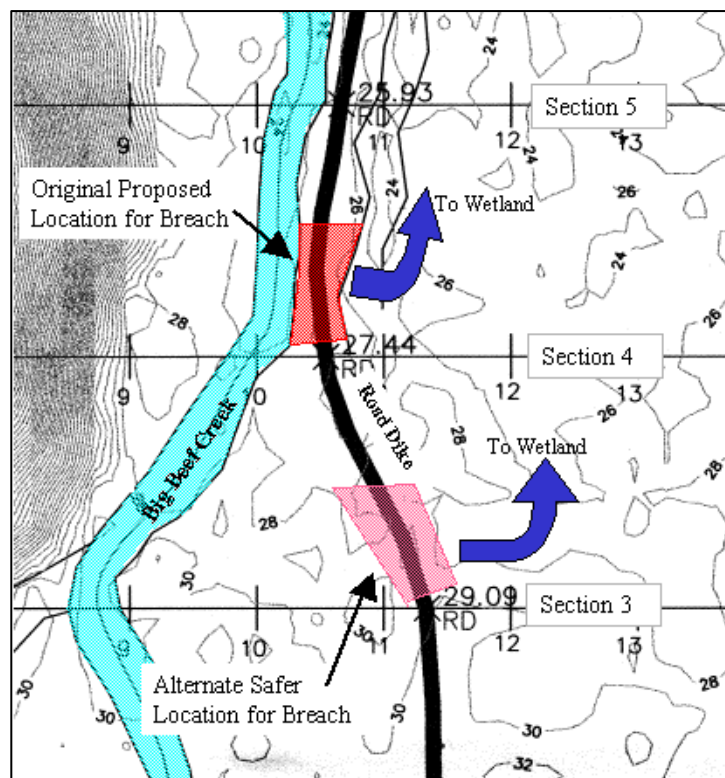**Figure 9: Potential Locations for Breach of Upstream Road**

Table 5: Required Entry Road Elevations For Case 4

Flood Event	Computed Flood Elevation	Road Elevation (w/ 0.5 foot Freeboard)	80% Confidence Flood Elevation	80% Confidence Road Elevation
100-year	17.6 ft.	18.1 ft.	17.9 ft.	18.4 ft.
200-year	17.8 ft.	18.3 ft.	18.1 ft.	18.6 ft.
500-year	18.1 ft.	18.6 ft.	18.4 ft.	18.9 ft.

The results of this analysis confirmed that this layout would reduce the potential for flooding at the field station, both upstream and downstream from the entry road. The return flow channel would provide a controlled location for the floodwaters to return to the creek from the wetland. It would also reduce the amount of fill that needs to be added to the entry road to protect the Field Station. If the upstream road dike is breached away from the creek near section 3, it will reduce the potential for the creek to cut a new channel into the wetland.

Appendix A shows graphical Cross Section flow data from the HEC-RAS Model for all the cross sections in the Case 4 Scenario. The sections show the flood levels computed for the 100, 200 and 500-year events based on Bulletin 17B. Appendix B provides tabular hydraulic data from the HEC-RAS model.

Summary and Conclusions

In summary, this analysis looked at different flooding scenarios along lower Big Beef Creek. Critical areas of interest included:
- The University of Washington Big Beef Creek Field Station, including a recently constructed spawning channel,
- A wetland area along the east side of valley upstream from the field station,
- The entry road to field station that crosses the lower end of the wetland
- An access road that acts as a levee between the wetland and the main Big Beef Creek channel

Four different cases were examined using the HEC-RAS computer program, for flooding during the 100, 200 and 500-year events along lower Big Beef Creek. These cases are discussed as follows:

1. **Case 1** looked at the existing conditions along Big Beef Creek and the UW Field Station. The HEC-RAS analysis showed that there is a high risk of flooding into the spawning channel and adjacent buildings because a) the access road dike near Section 4 is susceptible to overtopping and failure, b) the creek is perched higher than the wetland in this area, which could result in the creek forming a new channel into the wetland during a flood, and c) the entry road berm between the spawning channel and wetland is not high enough to protect the field station from flooding.

2. **Case 2** looked at the minimum modifications for protecting the Field Station and associated structures. The proposed solution would be to raise the entry road grade 2-3 feet to act as a levee, shunting flood flows back toward the main creek channel. However, floodwaters would still flow uncontrolled across the parking lot and storage buildings between sections 9 and 10. There could be significant erosion and scour in this area. Also, this option would not prevent Big Beef Creek from cutting a new channel through the wetland area, potentially dewatering portions of the current channel.

3. **Case 3** investigated the proposal to open up the wetland area to flooding by breaching the old road dike near Section 4, without making any changes to protect structures at the UW Field Station. The results of this analysis were nearly identical to Case 1. Even if erosion protection is provided at the breach section, it is still likely that most of the flood flow would enter the wetland channel, and dewater the main channel. Since there is no means of returning flow to the main creek from the wetland, the floodwaters would overtop the entry road, as well as the adjacent parking lot and buildings. Flood damage would be expected in the spawning channel and adjacent buildings.

4. **Case 4** examined breaching the road dike as in Case 2, but providing a return-flow channel near Section 8 to discharge flows from the wetland back to the main stream. Also, the entry road dike would be raised as in Case 1 to protect the critical facilities at the Field Station. This analysis showed that the construction of a return flow channel would reduce flooding levels in the wetland, as well as provide a controlled location for the floodwaters to return to the creek. If the upstream road dike is breached near section 3 instead of Section 4, it is likely that Big Beef Creek would not jump over to the wetland, but would retain its current channel.

Based on these results, it is recommended that the Case 4 modifications be implemented, if the UW wishes to reopen the wetland area to flooding. It is also recommended that the breach section in the access road be located away from the main stream channel to reduce the potential for Big Beef Creek eroding a new channel into the wetland. To this end, beaching the road in the vicinity of Cross Section 3 would be preferable, provided the topography carries overflow to the wetland.

If the UW decides not to open up the wetland, it is strongly recommended that the Case 2 modifications be constructed. This would provide the minimum protection for the spawning channel and buildings at the field station from flooding.

References

[1] U.S. Geological Survey, Peak Flow Data from Website for Station 12069550, http://water.usgs.gov/nwis/peak/?site_no=12069550, 2001

[2] U.S. Geological Survey, PEAKFQ, Annual Flood Frequency Analysis Using Bulleting 17B Guidelines, Reston VA, 1998.

[3] U.S. Army Corps of Engineers, HEC-RAS River Analysis System, Version 3.0, January 2001, Hydrologic Engineering Center, Davis CA.

Pool

18

14

Pool

10

17

15

13

11

9

7

5

3

1

1

17

15

13

11

9

7

5

3

1

Fish
weir

Pool

17

15

13

11

9

7

5

3

1

Fish
weir

a. 1969
before
channelization
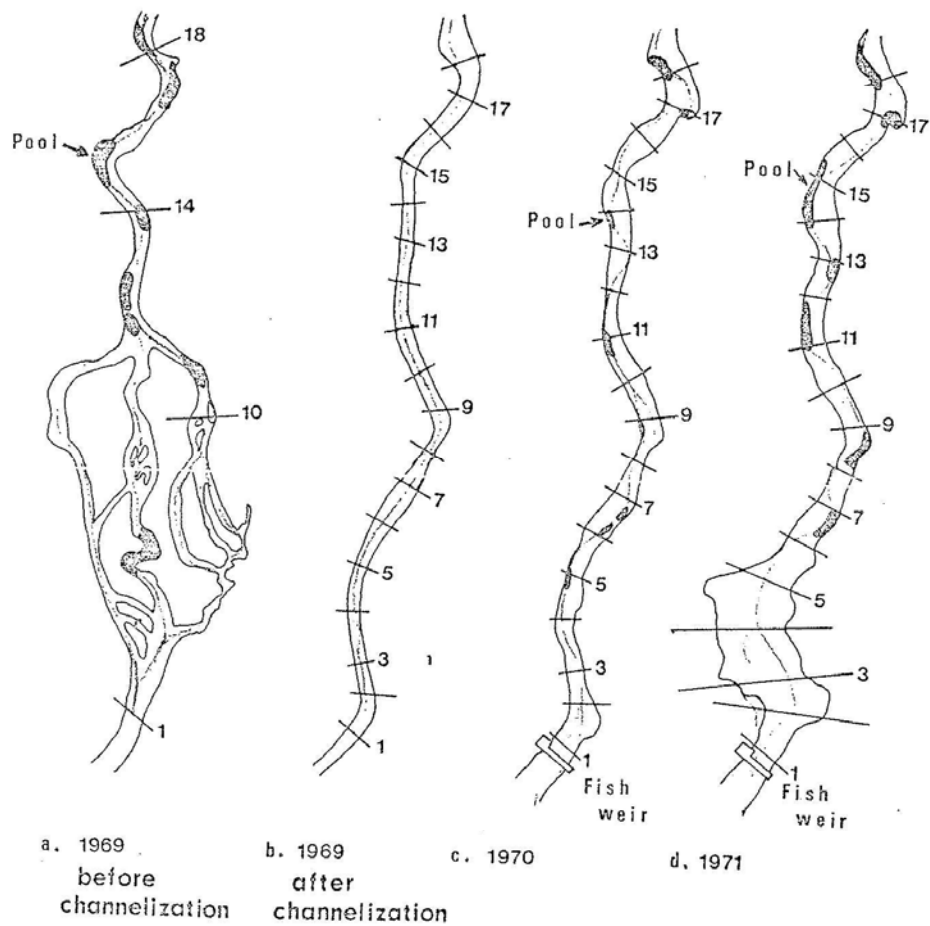
b. 1969
after
channelization

c. 1970

d. 1971

Fig. 10.   Occurrence of pools in the channelized area before and
after stream alteration.